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AUTHOR Triska, Olive H.; And Others
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ABSTRACT

The domination of the information processing approach has shifted research from problem solving strategies to the structure and organization of knowledge that characterizes expertise. The purpose of this study was to compare the reasoning processes of 12 clinicians and 40 medical students as they responded to 6 positively stated multiple choice items involving patient diagnosis. The theoretical framework that guided the study was the information processing theory of J. R. Anderson, which sees knowledge acquisition as a process in which individuals progress from novices to experts in sequential stages over a period of time. Clinician and student protocols were analyzed using subsets of behaviors related to the item stem and the choice options. The reasoning processes of the students and clinicians differed. While clinicians integrated the information presented in the stem and activated a hypothesis to explain all the information, students restated and focused on pieces of information in the stem, and used short connective links to relate one piece of information to an interpretation or possible answer. The differences in behavior appeared consistent with the Anderson information processing theory. Since students solve items by heeding the alternatives, each alternative presented should be integral to the central concept of the item and indicate a knowledge deficit or misconception. An appendix presents the multiple choice items. (Contains three tables and six references.) (SLD)

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CLINICIANS' PERCEPTIONS OF MEDICAL STUDENTS' REASONING ON MULTIPLE CHOICE ITEMS

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Olive H. Triska*,
Faculty of Education, University of Alberta, Edmonton Alberta, Canada

Thomas O. Maguire,
Faculty of Education and Faculty of Medicine, University of Alberta, Edmonton Alberta, Canada

Ernest N. Skakun,
Faculty of Medicine, University of Alberta, Edmonton Alberta, Canada

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Clinicians' Perceptions of Medical Students' Reasoning on Multiple Choice Items

Within the context of medical education, recent investigations of reasoning have been pursued from the perspective of developments in cognitive science. The domination of the information processing approach has shifted research from problem solving strategies to the structure and organization of knowledge that characterizes expertise. The purpose of this study was to compare the reasoning processes of 12 clinicians and 40 students as they responded to six positively stated multiple choice items.

Unsuccessful problem solvers are unable to integrate information and generated many diagnoses. Patel, Groen, and Arocha (1990) approached the study of expert reasoning using propositional networks. They found that expert clinicians, working within their area of expertise, use a form of forward reasoning, moving from facts and observations to diagnoses as they solve problems in their areas of expertise. Novices and clinicians working outside their areas of expertise make more use of backward reasoning. Experts relied on clinically-based models while novices incorporated pathophysiological data to explain a patient's problem. In these investigations subjects with varying levels of education and experience were presented with a written description of a patient case as a stimulus. After the case was read, it was removed and subjects were asked to recall as much of the text as possible, explain the underlying pathophysiology, and provide a diagnosis.

Viewing the organization of knowledge as a set of syntactic and semantic axes, Lemieux and Bordage (1992) showed that successful problem solvers use several semantic axes and that a patient's clinical features are organized into clusters that signify deep and broad understanding.

Few investigations have examined the structure and organization of knowledge using MC items as stimulus material. Using a think aloud approach, Skakun, (1994) and Skakun, Maguire, and Cook (1994), asked forty third and fourth year medical students to think aloud as they responded to thirty multiple choice items. From the problem solving literature and student think aloud protocols, Skakun (1994) developed a list of 25 student-item interaction activities. Three categories of activities emerged from the list. The first category consisted of five actions that dealt with whether students generated an answer before reading the alternatives and with students treatment of the alternatives. Sixteen behaviours related

to the disposition of alternatives comprised the second category. The third category consisted of four activities related to successful problem solving.

Students used one of three broad strategies when responding to the items. In the first strategy, students read the stem and then searched the alternatives for the answer. Upon selecting an answer, the remaining alternatives were discarded with reasons. In the second strategy, students read the stem, generated an answer, and then went on to search the alternatives for the generated answer or a better answer. Incorrect options were discarded with reasons. In the third strategy, students activated a hypothesis (diagnosis), although the items did not request a diagnosis. Instead, the item requested other aspects such as treatment, management, and appropriate investigations. Upon reading the item, students activated hypotheses, determined the task, and then went on to search the alternatives for the answer. Alternatives were discarded with reasons.

Theoretical Framework

The theoretical framework that guided this study was Anderson's (1993; 1995) information processing theory (ACT*). According to Anderson, knowledge acquisition is a process in which individuals progress from novices (e.g., medical students) to experts (e.g., clinicians) in sequential stages over a period of time. In the declarative stage, an individual acquires facts and concepts characterized as schema. With further education and experience, schemas are compiled and assimilated into performance schema. This allows for rapid retrieval of information (procedural knowledge). The third stage, efficiency, automaticity, and metacognition occur when performance is spontaneous and conscious cognition is minimal.

Method

The clinicians for this study consisted of four family practitioners and eight internal medicine specialists, all with teaching appointments in the Faculty of Medicine. For this study, the think aloud protocols of students interacting with six multiple choice items were selected from Skakun (1994).

Six positively stated MC items were selected from the Skakun, Maguire, and Cook (1994) study. The items are listed in Appendix 1.

Clinicians thought aloud while solving each MC item. As part of the interview, each participant was briefed on the purpose, tasks, and procedures, and given an example of a think aloud protocol. In addition, each clinician was given a practice item before the interview began. All interviews were audiotaped, transcribed, and verified by listening to the audiotape while reading the protocol for accuracy.

Analysis

The clinician and student protocols were analyzed using a subset of the categories reported by Skakun, Maguire, and Cook (1994). The eight subsets of behaviours reported in the present paper consist of two larger sets of behaviours - those related to the stem and those related to the disposition of the options. Coding of the categories in the clinicians' and students' protocols was done independently by two individuals, then the results were discussed. Resolution was reached on the coding of the behaviours.

The subsets of behaviours for those that describe the stem behaviours were of four types. Students tended to restate the information in the stem in their own words, paraphrase the scenario (restates). Other individuals redescribed or focussed on a key feature and defined it in a different way (redescribes). Both of these strategies are examples of backward reasoning and are more typical of novice reasoning. Some individuals generated an answer or problem space using the information presented in the stem immediately, before reading the alternatives (generates a/s). Others activated a hypothesis using the information presented in the stem (activates hyp.). The last two behaviours are examples of forward reason, and are more typical of expert reasoning.

Clinicians and students disposed of options using four strategies. When forward reasoning was used, individuals tended to use two complimentary strategies. Individuals would discard an option because it would not represent the first course of action, it was inappropriate or less appropriate, unimportant or less important (priority). Alternatives were eliminated because the description or data in the stem did not match the alternative (description). These two behaviours were interpreted as a holistic approach to eliminating the alternatives, characteristic of forward reasoning and expert behaviour. Individuals who used backward reasoning tended to use discreet bits of information in the alternatives and try to link them with information in the stem. They eliminated alternatives after reading the stem by stating that the option was

unlikely, rare, or less likely than another option (likelihood). Individuals tended to eliminate alternatives by elaborating on specific pieces of clinical information presented in the stem, associating discreet bits of information. Condition-action pairs (i.e., if-then statements) were commonly used (association). These behaviours were typical of individuals who were novices, that is, who used backward reasoning to solve an item. They approached solving the item using an atomistic strategy.

To compare the differences between the clinicians' and students' reasoning behaviour, the following procedure was used. First, the clinicians' and students' behaviours were standardized by dividing the number of occurrences of each behaviour for each item by the clinicians (12) and students (40) respectively. Second, the difference between the clinicians' and students' standardized behaviour ratio was computed. Third, values greater than $|0.20|$ were considered as indicative of practical significance.

Results

As shown in Table 1, the items' disciplines and classifications varied as did the clinicians' and students' item difficulties. Not all clinicians chose the keyed response to every item. From Table 1 we can see that the rank order of difficulties differs between the two groups. Since for all items except one, a greater proportion of clinicians chose the keyed option, the difference may be largely accounted for by the greater clinical experience amongst the clinician group.

Tables 2 and 3 present clinicians' and students' approaches to the treatment of the item stems and alternatives. Differences between standardized behaviour ratios favouring clinicians are noted with (C), and a (S) is used for differences favouring the students. An equals sign (=) appears for no differences. To illustrate the behaviours, an example for each category follows.

With respect to the behaviours related to the stem (Table 2), it appears that students are more likely to restate and redescribe the information presented in the stem than clinicians. For example, as shown in Table 2, more students restated and redescribed the information in the stem for item 347 than did clinicians as shown by the (C) sign. When students restated the information in the stem to

Table 1

Item Information and Clinicians' and Students' Performance

Item			Difficulty	
Number	Discipline	Classification	Clinician	Student
771	Gastrointestinal	Management	1.00	0.55
317	Gastrointestinal	Management	0.92	0.80
347	Pulmonary	Comprehension	0.92	0.53
582	Cardiovascular	Diagnosis	0.92	0.75
733	Neurology	Diagnosis	0.67	0.45
332	Pulmonary	Diagnosis	0.42	0.55

familiarize themselves with the scenario, they tended to paraphrase the details and facts. For item, 317, Student 038 said,

> A 24 year old flight attendant, tired and losing weight in spite of good appetite. Voluminous, pale, foul smelling stools. Foul smelling. I think about malabsorptive, like fat. Having bowel difficulty in early childhood and being fed diet consisting largely of bananas. I think the bananas because she probably have low potassium. That is why she is put on a diet. So she had bowel problems since early childhood. So it is malabsorptive confirmed by the fat in the stool. Blood picture shows anemia. If there is malabsorption is likely she has anemia. Which of the following diets would you select for this patient.
>
> I guess I'm thinking what causes malabsorptive diarrhea in young females. Celiac disease. But, I'm not very sure about the actual stool picture.

Table 2

Stem Related Behaviours

	Behaviour			
ID	Restates	Redescribes	Generates A/S	Activates Hyp.
771	=**	=	C***	=
317	=	S*	C	S
347	=	C	=	C
582	S	S	S	C
733	=	S	=	=
332	S	S	S	C

NOTE: S* Student; =** Difference | ·0.20 |; C*** Clinician.

Student 007 read the stem and quickly scanned the options of item 317, and focussed on malabsorption, explaining, "Well let's have a look here and see what they say, gluten free, lactose free, low fat, low residue, high residue. So all of this sounds like a malabsorption problem confirmed by an abnormal small bowel follow through."

However, when clinicians generated an answer from the stem for item 317, they were quick to offer an answer, the keyed response. Clinician C1 was particularly succinct saying,

A 24 year old airline attendant complains of feeling tired and losing weight in spite of a good appetite. For the past year she has noticed voluminous, pale, foul smelling stools. She recalls of

having been told of having bowel difficulty in early childhood and of being fed a diet largely consisting of bananas.

Radiological examination discloses an abnormal small bowel follow through. Biochemical analysis of the stool shows an increased amount of fat. The blood picture shows anemia. Which of the following diets would you select for this patient?

The answer is one, gluten free. She has celiac sprue. Nothing else fits.

There was no pause after this clinician read the stem. It was as though the answer were just a continuation of the stem. The response was given confidently, with no hesitation that it was the only correct answer.

When reading the stem, students were more likely to generate answers than clinicians, however, these did not necessarily match the keyed response or the distracters. This behaviour was typical for item 733. Student 035 exemplified this approach by thinking aloud,

56 year old man presents to his doctor with a one month history of intermittent right facial pain. So, right away I'm thinking that the differential diagnosis of facial pain could be sinusitis. It could be skin or muscle or something like that. It could be shingles. It could be neurological.

On examination he is found to have a diminished corneal reflex and slight hearing defect on the right so I'm thinking neurological already here.

. . . So basically I'm down to acoustic neuroma and trigeminal neuralgia, and I'd pick acoustic neuroma. Then again, I'm thinking about intermittent right facial pain. I'd still go with acoustic neuroma, number four because basically the trigeminal neuralgia can't explain the unilateral hearing loss unless that's a red herring which it could be, but number four I'll go with.

This student began thinking of various differential diagnoses after the first sentence, then focussed on a neurological disease. After reviewing the neuroanatomy of the cranium, matching each of the alternatives with the stem, went onto choose the keyed response.

When reading the stem, the clinicians' dominant behaviour was one of activating hypotheses. For four of the six items they were more likely to activate hypotheses than students. In doing so, they produced an integrated explanation of the information presented in the stem. In Item 733 Clinician C2 read the entire item and chose the keyed response, acoustic neuroma, as though there wasn't any question as to what the correct answer was by saying, "Based on the history, based on the physical findings, the best answer is number four, acoustic neuroma." When probed as to how the answer was thought of, this clinician said,

> 56 year-old man with a month history of pain. Pain. Symptom is pain. On physical examination he's got a diminished right corneal reflex. And, remembering the reflex arc of the corneal reflex, one would have to then call on some basic science in neuroanatomy to remember what the reflex arc for the corneal reflex is and realize that its got to be through the fifth cranial nerve.
>
> A slight hearing deficit or hearing defect, which has got to involve the eighth cranial nerve. Realizing that those nerves are pretty close together in the brain stem, would suggest, and on the same side, in usually in this area, the lesion points to the side the lesion is on, so the best answer in my mind would be acoustic neuroma.

This clinician activated a hypothesis, acoustic neuroma, while reading the stem. Again, the response was given quickly and confidently with no hesitation.

A similar behaviour was used in item 582 when Clinician C2 quickly and confidently activated a hypothesis from the stem for item 582 by explaining,

> One week after an anterior myocardial infarction, well, what kinds of complications occur after a myocardial infarction? You get pulmonary emboli, what else?
>
> A 55 year-old man complains of severe pain in the left leg. The leg is cool, pale, and pulseless. The most likely diagnosis is:
>
> I don't even have to read the list. He has thrown an embolus from his myocardium to an artery in his leg. I don't know if this is femoral or iliac or popliteal. Where in the leg? He has an

arterial embolism. Period. Straight forward.

Students used a different strategy. One student, Student 004 redescribed the scenario, then generated an answer from the stem. This student explained,

> First I'd start with reading the question which is, one week after an anterior myocardial infarct a 55-year-old man complains of severe pain in the left leg. The leg is cool, pale and pulseless. I know it was one week after an anterior myocardial infarction. I know the position of the infarction, the duration, the time. He's a 55-year-old man. He's got severe pain in the left leg. The leg being cool, pale and pulseless. I can tell that there must be something blocking the arterial circulation because if it's a venous blockage you would have a pulse and the leg would be warm. So I would look for the most likely diagnosis. I would look for something in the arterial circulation.

These examples illustrate differences in strategy between the clinicians and students when they read the stem. Clinicians tended to offer responses quickly, without hesitation. They did not falter in their decisions. Conversely, this behaviour was not predominant in the students. They tended to restate the stem and redescribe the scenario presented in the stem.

With respect to the behaviours elicited for the processing of alternatives (Table 3), clinicians were more likely to prioritize and describe the distractors. Clinicians viewed the item as a whole, and went on to describe the content of each alternative. Students tended to eliminate options using likelihoods and associative links, viewing each fragment of information in the stem and each distractor. One exception to this general practice occurred in item 771, where more students tended to use description than clinicians.

For item 317, Clinician C3 used both priority and descriptions to eliminate three alternatives explaining,

> Low fat. It might help symptomatically, but it's not getting at the major problem. Low residue. That's not going to make any difference. High residue, she's got enough diarrhea, you don't want

to give her any more. The best answer is number one.

This clinician described the conditions for each alternative, and qualified eliminating 'low fat' because it was not a major problem, then chose 'gluten free' because it was the answer.

Table 3

The Clinicians' and Students' Elimination of Alternatives Behaviours

Item	Association	Likelihood	Description	Prioritize
771	S*	=**	C***	S
317	S	C	C	C
347	S	C	C	C
582	S	=	=	C
733	S	S	C	C
332	S	=	C	C

NOTE: S* Student; =** Difference ≤ 0.20; C*** Clinician.

Clinician C5 took a similar approach, describing alternatives for item 347. This clinician said,

Acute pericarditis is more of a (five second pause) chest pain. It might not be pleuritic. It has different characteristics, relieved by sitting up. You may get a flu like illness with that as well. Pleurodynia, you wouldn't expect such an acute presentation, suddenly seized with pain.

When Student 16 eliminated alternatives in item 347, association and likelihood were used, as this student explained,

Mycoplasma pneumonia usually that doesn't give you severe left sided chest pain acutely it comes on more insidiously. (Association)

Pulmonary embolism. Another likely possibility. The pain and her risk factors involved if she has been previously hospitalized or injury to her leg veins or contraceptive pill might predispose her to pulmonary embolus. So two and three are the most common so far. (Likelihood)

Clinicians were more likely to prioritized alternatives for elimination for item 332. Clinician C4 used priority for the final elimination of the options. This clinician explained, "I think the most likely diagnosis would be three or four. Number five would be a close third, then one and two last. What we are seeing here is number four, bronchiectasis." Students used likelihoods to dispose of the alternatives. Student 005 stated, "Hypogammaglobulinemia is totally possible but unlikely. . . . Bronchiectasis is likely. Number 5 cystic fibrosis is very unlikely as they don't mention it at all. The answer is number 4, bronchiectasis."

These examples illustrate the behaviours used by clinicians and students when they eliminating distractors. Clinicians favoured priority and description to eliminate alternatives, consistent with expert reasoning. Students tended to use associative links and likelihoods, behaviours more commonly used by novice reasoners.

Conclusions

The reasoning processes of the clinicians' and students' differed for the six MC items. Clinicians integrated the information presented in the stem and activated a hypothesis to explain all the information. Conversely, students restated and focussed on pieces of information in the stem, and used short connective links to relate one piece of information to an interpretation or possible answer. This approach produced many answers. Because clinicians' and students' differed in their behaviours related to the processing of information in the stem, they also differed in their behaviours for eliminating options.

These differences in behaviour appear to be consistent with Anderson's (1993, 1995) ACT* theory. The clinicians' behaviour indicated that their knowledge was well structured and integrated. This suggests that clinicians were functioning at the procedural level of knowledge acquisition. In contrast, students' knowledge was not elaborate and well structured. Partly because of their level of education, and because of lack of experience, they appear to be at the declarative stage.

Educational Importance of the Study

The findings have implications when using MC items in medical education assessment and standard setting procedures. From an assessment perspective, students solve items by heeding each alternative, therefore, each alternative should be integral to the central concept of the item and indicate a knowledge deficit or misconception. The clinicians' lack of understanding of how students' solve MC items directs us to reexamine the construction of MC items, specifically the role of alternatives.

From a standard setting perspective, the inclusion of alternatives that do not represent errors or misconceptions in knowledge may lead to the setting of unreasonable passing scores. The clinicians' judgements may not reflect the students' level of knowledge at this phase of training.

References

Anderson, J. R. (1993). Problem solving and learning. *American Psychologist, 48* (1), 35-44.

Anderson, J. R. (1995). *Cognitive psychology and its implications*. (4th ed.) New York: NY, W. H. Freedman and Co.

Lemieux, M., Bordage, G. (1992). Propositional versus structural semantic analysis of medical diagnostic thinking. *Cognitive Science. 16*, 185-204.

Patel, V. L., Groen, G. J., Arocha, J. F. (1990). Medical expertise as a function of task difficulty. *Memory and Cognition. 18* (4), 394-406.

Skakun, E. N., Maguire, T. O., Cook, D. A. (1994). Strategy choices in responding to multiple-choice items. *Academic Medicine, October Supplement. 69*(10), 57-59.

Triska, O. H. (1996). *The Validity of Judgements in Standard Setting*. Unpublished doctoral dissertation. University of Alberta, Edmonton, Alberta, Canada.

Appendix 1 - Multiple Choice Items

ITEM 1: ID. 771
The irritable bowel syndrome in adults is a diagnosis of exclusion. However, when this diagnosis is finally made, you should:

1. tell the patient the symptoms are always due to emotional stress.
2. tell the patient to take tranquilizers when symptoms flare.
3. tell the patient to return for a complete reevaluation (x-rays, blood work, etc.,) in three months.
*4. *counsel the patient and prescribe metamucil and bran.*
5. counsel the patient and prescribe Lomotil and Kaopectate.

ITEM 2: ID. 317
A 24 year-old airline flight attendant complains of feeling tired and losing weight in spite of a good appetite. For the past year she has noticed voluminous, pale, foul-smelling stools. She recalls being told of having bowel difficulty in early childhood and of being fed a diet largely consisting of bananas. Radiological examination discloses an abnormal small bowel follow through. Biochemical analysis of the stool shows an increased amount of fat. The blood picture shows anemia. Which of the following diets would you select for this patient?

*1. *Gluten free*
2. Lactose free
3. Low fat
4. Low residue
5. High residue

ITEM 3: ID. 347
A previously healthy 27 year-old female is suddenly seized with pleuritic pain in the left chest and shortness of breath. The most likely cause is:

1. mycoplasma pneumonia.
*2. *spontaneous pneumothorax.*
3. pulmonary embolism.
4. acute pericarditis.
5. pleurodynia.

ITEM 4: ID. 582
One week after an anterior myocardial infarction, a 55 year-old man complains of severe pain in the left leg. The leg is cool, pale, and pulseless. The most likely diagnosis is:

1. deep venous thrombosis.
2. ruptured left iliac aneurysm.
*3. *arterial embolism.*
4. A-V fistula.
5. arterial thrombosis.

ITEM 5: ID. 733
A 56 year-old man presents with a month history of intermittent right facial pain. On examination he is found to have a diminished right corneal reflex and a slight hearing defect on the same side. The diagnosis is:

1. right cerebral tumour.
2. trigeminal neuralgia.
3. otitis media.
*4. *acoustic neuroma.*
5. multiple sclerosis.

ITEM 6: ID. 332
A 28 year-old environmental activist has a history of having had pneumonia four times in the past twenty years. She has had a productive cough "all her life" which is worse in the winter. Physical examination reveals dullness, diminished breath sounds and numerous crepitations below T3 bilaterally. Her fingers are clubbed. The most likely diagnosis is:

1. hypogammaglobulinemia.
2. congenital heart disease.
3. bronchiolitis obliterans.
*4. *bronchiectasis.*
5. cystic fibrosis.